

AVIAN BILL-WIPING

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THIS first review of the taxonomic distribution of bill-wiping was undertaken to determine whether occurrence of this trait might aid in clarifying evolutionary and systematic relationships among higher categories of birds. Sources of data are my field observations of bill-wiping in 27 passerine species and the cited publications. Although hundreds of papers were consulted, some records of bill-wiping have undoubtedly been missed.

Bill-wiping typically involves rapid withdrawal of the side of the beak from base to tip closely adjacent to a foreign surface such as a branch or the ground. Excluded from consideration is wiping effected as the bill touches other parts of the body or that of another bird; such contacts are not usually described as bill-wiping.

Wiping varies in detail even for an individual bird at different times. Many kinds of structures provide wiping surfaces; I have seen passerines wipe on rope clothesline, fence wire, the edge of a metal birdbath, and the rim of a metal incinerator. Birds may or may not be perched on an object upon which they wipe, e.g., they may sit on one branch yet wipe on another nearby. If both sides of the bill are wiped in a single session, the sides are usually alternated. The number of wipes per session also varies widely (Morris, 1957*a*); the maximum rate reported is 90 wipes in a few minutes by the estrildine *Poephila bichenovi* (Morris, 1957*b*). Details of wiping are often difficult to see in the field. It is reported that the bill may be open or closed during wiping (Dunham, 1966*a*). Moreover, the bill reportedly often does not contact the object adjacent to which it is "wiped" (Hinde, 1953; Morris, 1954). If the bill fails to touch, the term "wiping" is misleading in a literal sense but still descriptively convenient. Despite its many variations, bill-wiping appears on the whole to be a distinctive and readily recognizable behavioral characteristic. Hinde (1953) and Hardy (1963) have published illustrations of bill-wiping.

FUNCTION

As judged from its frequency and the component movements of head, neck, trunk, and legs, bill-wiping involves cumulative expenditure of substantial time and energy. It therefore seems likely that such bill-wiping is selectively advantageous, even though the benefits are frequently obscure.

Cleaning.—As widely noted, birds frequently bill-wipe after eating messy foods such as suet, fruits, or juicy insects. Such wiping presumably aids sanitation and may help to maintain bill mobility and streamlining.

Those species not bill-wiping presumably use alternate ways of bill-cleaning, e.g., rubbing the bill on feathers or feet, pushing the bill into sand or other material, scratching with the foot, head shaking, and bathing. The cleaning methods appear to be effective, for free-living birds with conspicuously dirty bills are uncommon.

Honing.—Hardy (1963) notes for the parrot *Aratinga canicularis* that wiping may have a honing function, as wiping is sometimes done, evidently deliberately, on rough barked trees. A scraping noise heard during bill-wiping by the Rose-breasted Grosbeak (*Pheucticus ludovicianus*; Dunham, 1966a) might indicate substantial contact of the bill in wiping. However, in examining bills of study skins of various passerines with a binocular dissecting microscope, I find no clear evidence of the effects of wiping.

If bill-wiping serves in honing, it would seem essential that the bill grow sufficiently rapidly to offset wear through honing. Hypothetically one would expect selection to yield growth patterns not requiring special wiping to maintain or produce normal bill shapes. Unfortunately, not enough is known to correlate bill growth with bill-wiping, although there is much evidence that bills are continually growing and wearing away (Davis, 1954; Witschi and Woods, 1938; Wydoski, 1964). Wiping, serving primarily other functions, presumably produces some wear.

As judged from data assembled by Pomeroy (1962) on bill abnormalities, the frequency of malformed bills is not correlated with the occurrence or absence of bill-wiping.

Displacement activities.—Birds often bill-wipe without apparent debris on the bill and not immediately after feeding, bathing, drinking, or manipulation of objects with the bill. Indeed, as noted above, in some cases the bill reportedly does not contact the object against which it is "wiped" (cf. Morris, 1954). Much wiping thus meets a standard criterion for displacement activities in being seemingly irrelevant in a particular behavioral context.

It is difficult to categorize adequately the variety of situations in which displacement bill-wiping occurs. In a common case, a bird feeding on the ground is flushed by another bird or person and after flying to a branch engages in bill-wiping. Wiping movements occur frequently during agonistic behavior (see Coutlee, 1967; Dunham, 1966b; Nero, 1963). Furthermore, wiping may take place during predominantly sexual behavior as reported by Coombs (1960), Morris (1954), Moynihan (1963), and Summers-Smith (1963:24–25). Nice (1943:40) and Reiskind (1965) give examples of bill-wiping following contact with, or manipulation of, distasteful objects. Many of the foregoing examples involve situations in which birds are seemingly thwarted from completing an activity; however, some displacement wiping is associated with

transitions between activities without apparent thwarting. For example, I have observed a male Yellowthroat (*Geothlypis trichas*) fly to a branch, bill-wipe, and then begin to sing. Still other cases of wiping do not appear to involve thwarting, transition in activities, or cleaning. As examples, I have seen both the Yellow Warbler (*Dendroica petechia*) and the Prairie Warbler (*D. discolor*) bill-wipe during pauses in periods of singing. As Brown (1964) points out, the factors eliciting displacement bill-wiping may be very subtle so that detecting them in the field is often difficult or impossible.

That not all bill-wiping is a form of bill maintenance (i.e., cleaning or honing) is suggested by wiping without contact and also by intraspecific variations in frequency of wiping according to social rank or sex. Stokes (1963:13) observed more wiping in subordinate than in dominant partridges (*Alectoris*). In contrast, Hinde (1953) found bill-wiping commoner in dominant than subordinate Chaffinches (*Fringilla coelebs*). Morris (1954) recorded a higher frequency of bill-wiping by males than females during precopulatory displays of *Poephila guttata*. The selective advantages in bill-wiping and other displacement activities are relatively unstudied but may involve changes in the physiological state of the bird and in its responsiveness to environmental stimuli (cf. Rowell, 1961; Delius, 1966). It is curious that possible changes in internal state should be linked with such extensive body movements.

SYSTEMATIC SURVEY

Table 1 is a summary of species for which bill-wiping has been reported. For most species existing records of bill-wiping are fragmentary relative to the variety of contexts in which wiping may potentially occur. It is therefore premature to categorize species according to occurrence or frequency of bill-wiping in particular behavioral contexts. However, interspecific variations of this kind may occur widely. For example, Morris (1957*b*) found that *Lou-chura cucullata* frequently preens as a displacement activity in contexts in which other estrildines show displacement bill-wiping.

Probably all groups listed in Table 1 bill-wipe as a means of cleaning the bill, but bill-wiping as a displacement activity has thus far been reported apparently for only Phasianidae, *Larus ridibundus*, Psittacidae, and many passerines. The wide distribution of bill-wiping in parrots and passerines suggests that wiping may be characteristic for these two orders.

I have found a few negative reports. Bill-wiping on a branch is unrecorded in waterfowl (Anatidae) despite arboreal perching by some species (McKinney, 1965:181). Variation in occurrence of wiping exists within the family Laridae. Tinbergen (1959:18, 52) notes that, when visited by a female, a male Black-headed Gull (*Larus ridibundus*) may peck at the ground and then bill-wipe.

TABLE 1
RECORDS OF BILL-WIPING

Family	Species	Reference
Tinamidae	<i>Nothoprocta cinerascens</i>	Lancaster, 1964: 280
Ardeidae	<i>Butoroides virescens</i>	Meyerriecks, 1960: 11
Tetraonidae	<i>Lagopus scoticus</i>	Watson and Jenkins, 1964: 146
Phasianidae	<i>Alectoris</i> sp.	Goodwin, 1953; Stokes, 1963
	<i>Gallus gallus</i>	Nice, 1962: 81
	<i>Colinus virginianus</i>	Nice, 1943: 40
Laridae	<i>Larus ridibundus</i>	Tinbergen, 1959
Psittacidae	<i>Aratinga canicularis</i>	Hardy, 1963
	<i>Brotogeris jugularis</i>	Power, 1967
	<i>Loriculus galagulus</i>	Buckley, 1968
	<i>L. vernalis</i>	" "
	<i>Melopsittacus undulatus</i>	Brockway, 1964
Picidae	<i>Colaptes auratus</i>	Kilham, 1959
	<i>Sphyrapicus varius</i>	Kilham, 1962; Lawrence, 1967: 120
Formicariidae	<i>Gymnopithys</i> , 3 species	Willis, 1967, 1968
Tyrannidae	<i>Empidonax traillii</i>	this study
Hirundinidae	<i>Iridoprocne bicolor</i>	" "
Corvidae	<i>Cyanocitta cristata</i>	Hardy, 1959; this study
	<i>C. stelleri</i>	" "
	<i>Aphelocoma caerulescens</i>	" "
	<i>A. ultramarina</i>	" "
	<i>Calocitta formosa</i>	" "
	<i>Corvus frugilegus</i>	Coombs, 1960
Paradisaeidae	<i>Parotia carolae</i>	Frith, 1968
	<i>Paradisaea raggiana</i>	Rand and Gilliard, 1968
Paridae	<i>Parus atricapillus</i>	Reiskind, 1965
	<i>P. carolinensis</i>	Brewer, 1961
	<i>P. major</i>	Howard, 1951
Troglodytidae	<i>Troglodytes troglodytes</i>	Armstrong, 1955: 30
	<i>Campylorhynchus</i> <i>brunneicapillus</i>	Ricklefs, 1966
	<i>Mimus polyglottos</i>	this study
Mimidae	<i>Dumetella carolinensis</i>	" "
	<i>Toxostoma curvirostre</i>	Ricklefs, 1966

TABLE 1 cont.

Family	Species	Reference
Turdidae	<i>Erithacus rubecula</i>	Mostler, 1935
	<i>Luscinia megarhynchos</i>	" "
	<i>Phoenicurus phoenicurus</i>	" "
	<i>Sialia sialis</i>	this study
	<i>Saxicola rubetra</i>	Mostler, 1935
	<i>Turdus migratorius</i>	this study
Sylviidae	<i>Hippolais icterina</i>	Mostler, 1935
	<i>Sylvia atricapilla</i>	" "
	<i>S. communis</i>	" "
Muscicapidae	<i>Ficedula hypoleuca</i>	" "
Bombycillidae	<i>Bombycilla cedrorum</i>	this study
Laniidae	<i>Lanius excubitor</i>	Cade, 1962
	<i>L. ludovicianus</i>	Miller, 1931: 220-221
Sturnidae	<i>Sturnus vulgaris</i>	this study
Vireonidae	<i>Vireo bellii</i>	Nolan, 1960
	<i>V. olivaceus</i>	this study
Parulidae	<i>Dendroica petechia</i>	" "
	<i>D. kirtlandii</i>	Mayfield, 1960: 66
	<i>D. discolor</i>	this study
	<i>Seiurus aurocapillus</i>	" "
	<i>Seiurus</i> sp.	" "
	<i>Geothlypis trichas</i>	" "
	<i>Setophaga ruticilla</i>	Ficken, 1962
Ploceidae	<i>Poephila guttata</i>	Morris, 1954
	<i>P. bichenovi</i>	Morris, 1957b
	<i>Lonchura cucullata</i>	" "
	<i>L. punctulata</i>	Moynihan and Hall, 1954
	<i>L. striata</i>	Eisner, 1960
	<i>Ploceus</i> (= <i>Sitagra</i>) <i>melanocephalus</i>	Crook, 1963
	<i>Passer domesticus</i>	Summers-Smith, 1963; 24-25; this study
Icteridae	<i>Xanthocephalus</i> <i>xanthocephalus</i>	Nero, 1963
	<i>Agelaius phoeniceus</i>	" " ; this study
	<i>Icterus galbula</i>	this study
	<i>Quiscalus quiscula</i>	Ficken, 1963; this study
	<i>Molothrus ater</i>	Nicc, 1943; Nero, 1963; this study

TABLE 1 cont.

Family	Species	Reference
Thraupidae	<i>Habia rubica</i>	Willis, 1960
	<i>H. gutturalis</i>	" "
Fringillidae		
Richmondinae	<i>Pheucticus ludovicianus</i>	Dunham, 1966a, 1966b; this study
Emberizinae	<i>Arremonops conirostris</i>	Moynihan, 1963
	<i>Junco hyemalis</i>	this study
	<i>Spizella arborea</i>	" "
	<i>S. passerina</i>	" "
	<i>Melospiza georgiana</i>	" "
	<i>M. melodia</i>	Nice, 1943: 21, 34; this study
Carduelinae	<i>Fringilla coelebs</i>	Hinde, 1953; Rowell, 1961
	<i>F. montifringilla</i>	Hinde, 1955-56
	<i>Serinus</i> sp.	Nice, 1943: 40; Hinde, 1955-56; Vince, 1961
	<i>Chloris chloris</i>	Hinde, 1955
	<i>Carduelis carduelis</i>	Hinde, 1955-56
	<i>Spinus tristis</i>	Coutlec, 1963, 1967
	<i>Acanthis flammea</i>	Dilger, 1960
	<i>Carpodacus purpureus</i>	this study
	<i>Loxia curvirostra</i>	Tordoff, 1954
	<i>Pyrrhula pyrrhula</i>	Hinde, 1955-56
	<i>Coccothraustes</i> <i>coccothraustes</i>	" "

Indeed, it regularly bill-wipes as a displacement activity, similar to the movements by which the bill is cleaned. This species thus differs from the Herring Gull (*Larus argentatus*) which tugs at vegetation rather than bill-wiping (Tinbergen, 1959). This constitutes an example of intrageneric variation in the occurrence of bill-wiping. Van Iersel and Bol (1958:7) in extensive observations of the terns *Sterna hirundo* and *S. sandvichensis* saw no bill-wiping.

For the majority of families there are neither positive nor negative records. In watching such species as Killdeer (*Charadrius vociferus*), Rock Doves (*Columba livia*), and Mourning Doves (*Zenaidura macroura*), I have failed to see bill-wiping, but further data are needed. Present negative evidence suggests that bill-wiping is absent, or occurs rarely, in a variety of waterbirds.

Another questionable group is the Trochilidae. DuBois (1938) reports an

TABLE 2
EARLIEST APPEARANCE OF BILL-WIPING IN SOME PASSERINE SPECIES

Species	Days Posthatching	Reference
<i>Cyanocitta cristata</i>	15	Hardy, 1959
<i>Campylorhynchus brunneicapillus</i>	24	Ricklefs, 1966
<i>Toxostoma curvirostre</i>	16	" "
<i>Lanius ludovicianus</i>	33	Miller, 1931: 220-221
<i>Setophaga ruticilla</i>	8	Ficken, 1962
<i>Molothrus ater</i>	14	Nice, 1943: 40
<i>Pheucticus ludovicianus</i>	7-11	Dunham, 1966a
<i>Melospiza melodia</i>	11	Nice, 1943: 21, 34
<i>Serinus canaria</i>	11 or earlier	Nice, 1943: 40

unsuccessful effort by a female Rufous Hummingbird (*Selasphorus rufus*) to wipe away a feather by rubbing her bill on the rim of the nest. After failing to dislodge the feather with her tongue, she eventually removed it by jabbing her bill downward into the nest. It is uncertain that the bill-wiping observed by DuBois corresponds to that of other birds.

EVOLUTIONARY INTERPRETATIONS

Although a few data are available on the ontogeny of bill-wiping (see Table 2 and the references cited therein), we know little about the possible roles of practice and learning in maturation of the trait. Nevertheless, in view of the absence of records of intraspecific variation in occurrence, the character appears to be species-specific and hence presumably strongly influenced genetically.

Clearly much more must be learned about the occurrence of bill-wiping before it can be broadly used taxonomically. Particularly needed are observations on the presence or absence of the trait in additional nonpasserine groups. Bill-wiping is a seemingly simple feature and hence may have been acquired or lost more than once in evolutionary history. However, bill-wiping appears to be as potentially suitable a taxonomic character as some simple, but widely cited, morphological ones (e.g., feathering of the oil gland; Clark, 1964).

As displacement activities are commonly believed to be a frequent evolutionary source for movements in stereotyped behavior, it would not be surprising if bill-wiping were found as a source in the evolution of certain displays. There are a few possible examples. Orians and Christman (1968:76) suggest that one possible source of the bill-down postures in certain icterids and ploceids might be bill-wiping (see also Mitchell, 1966). Moreover, the

sweeping movements of White-breasted Nuthatches (*Sitta carolinensis*) in possible chemical defense of nests against squirrels may have been derived from bill-wiping (Kilham, 1968).

SUMMARY

Bill-wiping is reviewed for Tinamidae, Ardeidae, Tetraonidae, Phasianidae, Psittacidae, Picidae, and 20 families of Passeriformes. Bill-wiping occurs in at least one, but not all, species of Laridae and has not been reported for Anatidae.

Functional interpretation of this behavior as a displacement activity remains uncertain. Bill-wiping appears to have moderate potential utility as a taxonomic character.

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LITERATURE CITED

- ARMSTRONG, E. A. 1955. The wren. Collins, London.
- BREWER, R. 1961. Comparative notes on the life history of the Carolina Chickadee. *Wilson Bull.*, 73:348-373.
- BROCKWAY, B. F. 1964. Ethological studies of the Budgeriger (*Melopsittacus undulatus*): non-reproductive behavior. *Behaviour*, 22:193-222.
- BROWN, J. L. 1964. The integration of agonistic behavior in the Steller's Jay *Cyanocitta stelleri* (Gmelin). *Univ. California Publ. Zool.*, 60:223-328.
- BUCKLEY, F. G. 1968. Behaviour of the Blue-crowned Hanging Parrot *Loriculus galgulus* with comparative notes on the Vernal Hanging Parrot *L. vernalis*. *Ibis*, 110:145-164.
- CADE, T. J. 1962. Wing movements, hunting, and displays of the Northern Shrike. *Wilson Bull.*, 74:386-408.
- CLARK, G. A., JR. 1964. Ontogeny and evolution in the megapodes (Aves: Galliformes). *Postilla*, 78:1-37.
- COOMBS, C. J. F. 1960. Observations on the rook *Corvus frugilegus* in southwest Cornwall. *Ibis*, 102:394-419.
- COUTLEE, E. L. 1963. Maintenance behavior of the American Goldfinch. *Wilson Bull.* 75:342-357.
- COUTLEE, E. L. 1967. Agonistic behavior in the American Goldfinch. *Wilson Bull.*, 79: 89-109.
- CROOK, J. H. 1963. The basis of flock organisation in birds. Pp. 125-149. *In*: W. H. Thorpe and O. L. Zangwill (Ed.), *Current problems in animal behaviour*. Cambridge Univ. Press, Cambridge, England.
- DAVIS, J. 1954. Seasonal changes in bill length of certain passerine birds. *Condor*, 56: 142-149.
- DELIUS, J. D. 1966. Displacement activities and arousal. *Nature*, 214:1259-1260.
- DILGER, W. C. 1960. Agonistic and social behavior of captive Redpolls. *Wilson Bull.* 72:115-132.
- DUBOIS, A. D. 1938. Observations at a Rufous Hummingbird's nest. *Auk*, 55:629-641.
- DUNHAM, D. W. 1966a. Maintenance activities of the Rose-breasted Grosbeak. *Wilson Bull.*, 78:68-78.
- DUNHAM, D. W. 1966b. Agonistic behavior in captive Rose-breasted Grosbeaks, *Phenic-ticus ludovicianus* (L.). *Behaviour*, 27:160-173.

- EISNER, E. 1960. The biology of the Bengalese Finch. *Auk*, 77:271-287.
- FICKEN, M. S. 1962. Maintenance activities of the American Redstart. *Wilson Bull.*, 74:153-165.
- FICKEN, R. W. 1963. Courtship and agonistic behavior of the Common Grackle, *Quiscalus quiscula*. *Auk*, 80:52-72.
- FRITH, C. 1968. Some displays of Queen Carola's Parotia. *Avic. Mag.*, 74:85-90.
- GOODWIN, D. 1953. Observations on voice and behaviour of the Red-legged Partridge *Alectoris ruja*. *Ibis*, 95:581-614.
- HARDY, J. W. 1959. Studies in behavior and phylogeny of certain New World jays (Carrulinae). *Univ. Kansas Sci. Bull.*, 42:13-149.
- HARDY, J. W. 1963. Epigamic and reproductive behavior of the Orange-fronted Parakeet. *Condor*, 65:169-199.
- HINDE, R. A. 1953. The conflict between drives in the courtship and copulation of the Chaffinch. *Behaviour*, 5:1-31.
- HINDE, R. A. 1955. The courtship and copulation of the Greenfinch (*Chloris chloris*). *Behaviour*, 7:207-232.
- HINDE, R. A. 1955-56. A comparative study of the courtship of certain finches (Fringillidae). *Ibis*, 97:706-745; 98:1-23.
- HOWARD, L. 1951. Abnormal bill of Great Tit. *Brit. Birds*, 44:350.
- KILHAM, L. 1959. Early reproductive behavior of flickers. *Wilson Bull.*, 71:323-336.
- KILHAM, L. 1962. Nest sanitation of Yellow-bellied Sapsucker. *Wilson Bull.*, 74:96-97.
- KILHAM, L. 1968. Reproductive behavior of White-breasted Nuthatches. I. Distraction display, bill sweeping, and nest hole defense. *Auk*, 85:477-492.
- LANCASTER, D. A. 1964. Biology of the brushland tinamou, *Nothoprocta cinerascens*. *Bull. Amer. Mus. Nat. Hist.*, 127:269-314.
- LAWRENCE, L. DE K. 1967. A comparative life-history study of four species of woodpeckers. *Ornithol. Monogr.*, 5:1-156.
- MAYFIELD, H. 1960. The Kirtland's Warbler. Cranbrook Institute of Science, Bloomfield Hills, Michigan.
- McKINNEY, F. 1965. The eomfort movements of Anatidae. *Behaviour*, 25: 120-220.
- MEYERRIECKS, A. J. 1960. Comparative breeding behavior of four species of North American herons. *Publ. Nuttall Ornithol. Club*, 2.
- MILLER, A. H. 1931. Systematic revision and natural history of the American shrikes (Lanius). *Univ. California Publ. Zool.*, 38:11-242.
- MITCHELL, I. G. 1966. Courtship patterns in some species of Coliusspinner. *Ostrich*, 37:47-53.
- MORRIS, D. 1954. The reproductive behaviour of the Zebra Finch (*Poephila guttata*), with special reference to pseudofemale behaviour and displacement activities. *Behaviour*, 6:271-322.
- MORRIS, D. 1957a. "Typical intensity" and its relation to the problem of ritualisation. *Behaviour*, 11:1-12.
- MORRIS, D. 1957b. The reproductive behaviour of the Bronze Mannikin, *Lonchura cucullata*. *Behaviour*, 11:156-201.
- MOSTLER, G. 1935. Beobachtungen zur Frage der Wespenmimikry. *Z. Morphol. Ökol. Tiere*, 29:381-454.
- MOYNIHAN, M. 1963. Display patterns of tropical American "nine-primaried" songbirds. III. The Green-backed Sparrow. *Auk*, 80:116-144.

- MOYNIHAN, M., AND M. F. HALL. 1954. Hostile, sexual, and other social behaviour patterns of the Spice Finch (*Lonchura punctulata*) in captivity. *Behaviour*, 7:33-76.
- NERO, R. W. 1963. Comparative behavior of the Yellow-headed Blackbird, Red-winged Blackbird, and other icterids. *Wilson Bull.*, 75:376-413.
- NICE, M. M. 1943. Studies in the life history of the Song Sparrow. II. The behavior of the Song Sparrow and other passerines. *Trans. Linnaean Soc. New York*, 6.
- NICE, M. M. 1962. Development of behavior in precocial birds. *Trans. Linnaean Soc. New York*, 8.
- NOLAN, V., JR. 1960. Breeding behavior of the Bell Vireo in southern Indiana. *Condor*, 62:225-244.
- ORIAN, G. H., AND G. M. CHRISTMAN. 1968. A comparative study of the behavior of Red-winged, Tricolored, and Yellow-headed Blackbirds. *Univ. California Publ. Zool.*, 84.
- POMEROY, D. E. 1962. Birds with abnormal bills. *Brit. Birds*, 55:49-72.
- POWER, D. M. 1967. Epigamic and reproductive behavior of Orange-chinned Parakeets in captivity. *Condor*, 69:28-41.
- RAND, A. L., AND E. T. GILLIARD. 1968. Handbook of New Guinea birds. Natural History Press, Garden City, New York.
- REISKIND, J. 1965. Behaviour of an avian predator in an experiment simulating Batesian mimicry. *Anim. Behav.*, 13:466-469.
- RICKLEFS, R. E. 1966. Behavior of young Cactus Wrens and Curve-billed Thrashers. *Wilson Bull.*, 78:47-56.
- ROWELL, C. H. F. 1961. Displacement grooming in the Chaffinch. *Anim. Behav.*, 9:38-63.
- STOKES, A. W. 1963. Agonistic and sexual behaviour in the Chukar Partridge (*Alectoris graeca*). *Anim. Behav.*, 11:121-134.
- SUMMERS-SMITH, D. 1963. The House Sparrow. Collins, London.
- TINBERGEN, N. 1959. Comparative studies of the behaviour of gulls (Laridae): a progress report. *Behaviour*, 15:1-70.
- TORDOFF, H. B. 1954. Social organization and behavior in a flock of captive, nonbreeding Red Crossbills. *Condor*, 56:346-358.
- VAN IERSEL, J. J. A., AND A. C. A. BOL. 1958. Preening of two tern species, a study on displacement activities. *Behaviour*, 13:1-88.
- VINCE, M. A. 1961. "String-pulling" in birds. III. The successful response in Greenfinches and Canaries. *Behaviour*, 17:103-129.
- WATSON, A., AND D. JENKINS. 1964. Notes on the behaviour of the Red Grouse. *Brit. Birds*, 57:137-170.
- WILLIS, E. O. 1960. A study of the foraging behavior of two species of ant-tanagers. *Auk*, 77:150-170.
- WILLIS, E. O. 1967. The behavior of bicolored antbirds. *Univ. California Publ. Zool.*, 79:1-132.
- WILLIS, E. O. 1968. Studies of the behavior of Lunulated and Salvin's Antbirds. *Condor*, 70:128-148.
- WITSCHI, E., AND R. P. WOODS. 1936. The bill of the sparrow as an indicator for the male sex hormone. II. Structural basis. *J. Exp. Zool.*, 73:445-459.
- WYDOSKI, R. S. 1964. Seasonal changes in the color of Starling bills. *Auk*, 81:542-550.
- BIOLOGICAL SCIENCES GROUP, UNIVERSITY OF CONNECTICUT, STORRS, CONNECTICUT
06268, 9 OCTOBER 1968.